Solutions

Physics 2414
Midterm #1 – Spring 2008

Version A

Multiple choice (6 points each)

$speed = \frac{distance}{time}$

1) You drive 4 miles at 30 mi/hr and then another 4 miles at 50 mi/hr. What is your average speed for the entire 8 mile trip in mi/hr?

$d_1 = 4$ miles $\quad t_1 = \frac{4 \text{ miles}}{30 \text{ mi/hr}} = .133$ hr

$d_2 = 4$ miles $\quad t_2 = \frac{4 \text{ miles}}{50 \text{ mi/hr}} = .08$ hr

a) 40.0
b) 32.5
c) 42.1
(d) 37.6
e) 44.2

$speed = \frac{8 \text{ miles}}{.133 \text{ hr} + .08 \text{ hr}} = 37.6$ mi/h

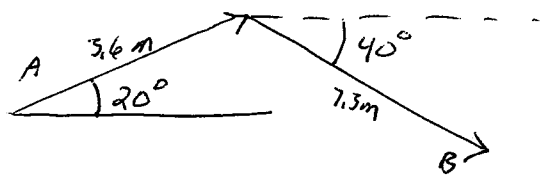
2) Suppose that an object is moving with constant acceleration. Make a statement concerning its motion with respect to time.

a) In equal times its speed increases by equal amounts.
(b) In equal times its velocity changes by equal amounts.
c) In equal times it moves equal distances.
d) More than one of the above statements is true
e) A statement cannot be made using the information given.

$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$

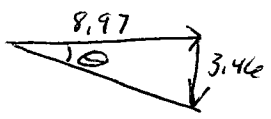
3) The position, x, of an object is given by the equation $x = A + Bt + Ct^2$, where t refers to time. What are the dimensions of A, B, and C?
a) distance, distance, distance
b) distance, time, time^2
(c) distance, distance/time, distance/ time^2
d) distance/time, distance/ time^2, distance/ time^3
e) distance, distance^2, distance^3

4) A student undergoes a first displacement of 3.6 meters at an angle of 20 degrees NORTH of EAST. The student undergoes a second displacement of 7.3 meters at an angle of 40 degrees SOUTH of EAST. The angle of the total displacement is,
a) 8 degrees SOUTH of EAST
b) 48 degrees SOUTH of EAST
(c) 21 degrees SOUTH of EAST
d) 62 degrees NORTH of EAST
e) 13 degrees SOUTH of EAST



$A_x = 3.6 \cos 20^\circ = 3.38$
$A_y = 3.6 \sin 20^\circ = 1.23$
$B_x = 7.3 \cos 40^\circ = 5.59$
$B_y = -7.3 \sin 40^\circ = -4.69$

$A_x + B_x = 3.38 + 5.59 = 8.97$
$A_y + B_y = 1.23 - 4.69 = -3.46$



$\theta = \tan^{-1} \frac{3.46}{8.97} = 21^\circ$

5) A ball is thrown off a cliff at an angle of 40^0 above the horizon with an initial velocity of 10.0m/sec. What is the *vertical* component of the velocity after 2 seconds?

a) 9.6 m/s downward
b) 6.4 m/s downward
c) 6.4 m/s upward
d) 13.2 m/s downward
e) 13.2 m/s upward

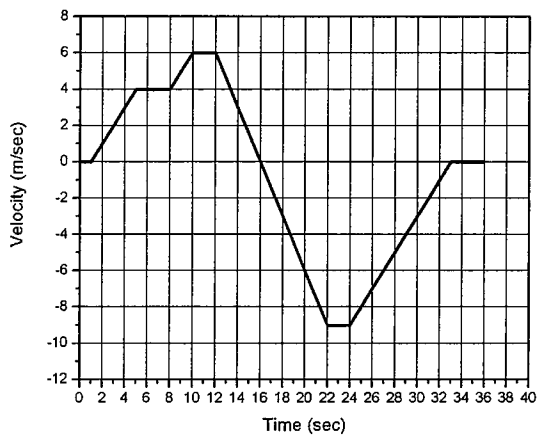
$V_y = V_{0y} - gt$
$= 10\,m/s \cdot \sin 40^\circ - 9.8\,m/s^2 \cdot 2.5 = -13.2\,m/s$

6) If an object is thrown into the air near the earth and eventually lands on the ground at the same level that it started. What variable(s) are required to determine how long it is in the air?

a) x velocity (v_x)
b) x displacement ($x-x_0$)
c) Initial y velocity (v_{0y})
d) Initial velocity (v_0)
e) More than one of the above variables

7) The figure below shows the velocity as a function of time of a runner. Which statement about the graph is true?

a) the displacement of the runner between time 0 and 36 secs is positive.
b) the runner never reverses direction.
c) the acceleration of the runner is always greater than or equal to zero.
d) the acceleration of the runner is always less than or equal to zero.
e) the displacement of the runner between time 0 and 36 secs is negative.



displacement is area under curve

8) You drop a ball at rest from a building rooftop. If after 1 second, it has fallen N meters, in the first 0.5 seconds, it would have fallen only

a) N/2 meters
b) N/4 meters
c) N/√2 meters
d) N/8 meters
e) N/√8 meters.

$\Delta y_1 = \frac{1}{2} g t_1^2 \quad \Delta y_2 = \frac{1}{2} g t_2^2$

$\frac{\Delta y_1}{\Delta y_2} = \frac{\frac{1}{2} g t_1^2}{\frac{1}{2} g t_2^2} = \frac{t_1^2}{t_2^2} \qquad t_1 = \frac{1}{2} t_2$

$\frac{\Delta y_1}{\Delta y_2} = \frac{t_1^2}{(2t_1)^2} = \frac{1}{4}$

9) A rifle bullet is fired at an angle of 30° below the horizontal with an initial velocity of 800 m/s from the top of a cliff 80 m high. How far from the base of the cliff does it strike the level ground below?

a) 130 m
b) 140 m
c) 150 m
d) 160 m
e) 2000 m

$x_0 = 0 \Rightarrow x = v_{ox} t = v \cos 30^\circ t = 800 \cos 30^\circ t =$

$x = 692.8\, t$

need t from y-equations

$y - y_0 = v_{oy} t - \frac{1}{2} g t^2$

$80\,m = -v \sin 30^\circ t - \frac{1}{2} g t^2$ (see below)

10) A ball is thrown straight up with a speed of 36.0 m/s. How long does it take to return to its starting point?

a) 3.67 s
b) 7.35 s
c) 11.0 s
d) 14.7 s
e) 9.11 s

$v_y = v_{oy} - gt$

at top $v_y = 0 \Rightarrow 0 = 36\ m/s - gt$

$t = \frac{36\ m}{9.8\ m/s^2} = 3.67\ s$

double this for total time in air $= 2(3.67\ s) = 7.35\ s$

11) Two bricks are released from the top of a building. Brick **A** weighs twice as much brick **B.** Brick **A** is dropped and the brick **B** is thrown straight up into the air. Which statement is true regarding this situation.

a) Brick **A** accelerates faster than the brick **B**.
b) Brick **B** accelerates faster than the brick **A**.
c) The bricks have the same magnitude of acceleration but the accelerations are in opposite directions.
d) The two bricks accelerate at the same rate during the entire time they are in the air.
e) The two bricks have the same acceleration except for the instant when the brick **B** reaches its maximum height.

9)

$\frac{1}{2} g t^2 + v \sin 30^\circ t + 80 = 0$

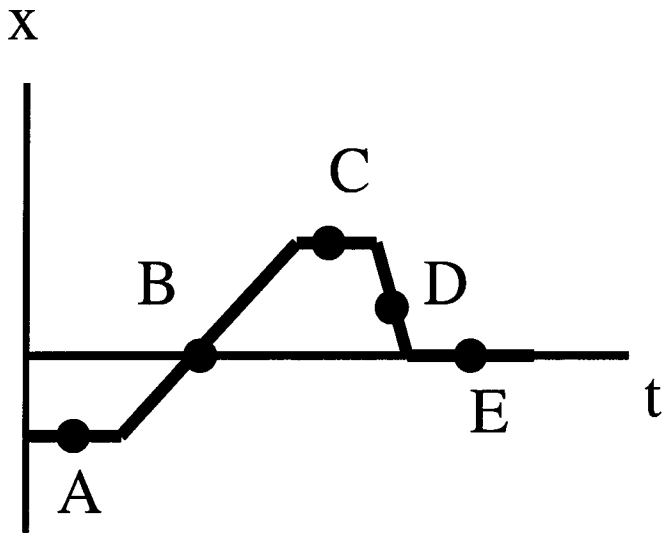
$t = \frac{-v \sin 30^\circ \pm \sqrt{(v \sin 30^\circ) - 4 \cdot \frac{1}{2} g \cdot 80}}{2 \cdot \frac{1}{2} g}$

$= \frac{400 \pm \sqrt{(400)^2 - 1568}}{g} = \frac{400 \pm 398}{9.8} = \boxed{.25}\ s$

$x = 692.8\ m/s \cdot 0.25 = 140\ m$

12) Consider the plot of X vs t at the right.
At which point is the object turning around?

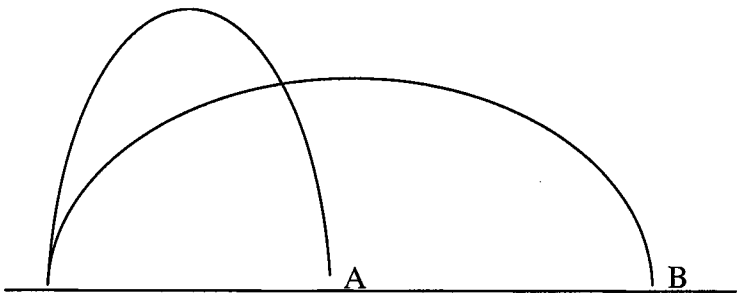
a) A
b) B
c) C
d) D
e) E



13) What is the conversion factor between km/h^2 and m/s^2?

a) 7.72×10^{-5} m/s^2
b) 2.78×10^{-1} m/s^2
c) 1.30×10^{4} m/s^2
d) 3.60 m/s^2
e) 7.72×10^{-6} m/s^2

$$\frac{1\,km}{hr^2}\left|\frac{1000m}{km}\right|\frac{hr}{3600s}\left|\frac{hr}{3600s}\right| = 7.72\times10^{-5}\ m/s^2$$



14) In the figure above two balls are thrown by two pitchers with the same initial speed at the same time. Which ball lands first?

a) Balls A and B land at the same time with the same speed.
b) Balls A and B land at the same time with different speeds.
c) Ball A lands first.
d) Ball B lands first.
e) Not enough information to tell

Voy smaller for B since it doesn't go as high.
since Voy smaller for B, it is in the air less and lands first.

15) Can an object's velocity change direction when its acceleration is constant?

a) No, this is not possible because it is always speeding up.
b) No, this is not possible because it is always speeding up or always slowing down.
c) Yes, this is possible, and a rock thrown straight up is an example.
d) Yes, this is possible, and a car that starts from rest, speeds up, slows to a stop, and then backs up is an example.
e) none of the above.

16) At the instant a traffic light turns green, a car that has been waiting at the intersection starts ahead with a constant acceleration of 2.00 m/s^2. At that moment a truck traveling with a constant velocity of 15.0 m/s overtakes and passes the car. What is the time necessary for the car to reach the truck?

a) 7.5 s
b) 15.0 s
c) 22.5 s
d) 30.0 s
e) 5.5 s

car $x_c = \frac{1}{2}at^2$

van $x_v = vt$

when $x_c = x_v$ they meet

$\frac{1}{2}at^2 = vt$

$\frac{1}{2}at = v$

$t = \frac{2v}{a} = \frac{2 \cdot 15\ m/s}{2\ m/s^2} = 15\ s$